

CLAIMS

What is claimed is:

1. An extreme (EUV) radiation source for generating EUV radiation, said source comprising:

a device for generating at least one stream of a target material, said target material being directed towards a target area;

a first laser source generating a pre-pulse laser beam directed towards the target area; and

a second laser source generating a main pulse laser beam directed towards the target area, said pre-pulse beam having a lower intensity than the main pulse beam, wherein the first laser and the second laser are timed so that the pre-pulse beam arrives at the target area before the main pulse beam, and wherein the main pulse beam interacts with the target material to generate the EUV radiation.

2. The source according to claim 1 wherein the main pulse beam and the pre-pulse beam are separated by an angle in the range of 0° - 180° at the target area.

3. The source according to claim 2 wherein the angle is about 30° .

4. The source according to claim 2 wherein the angle is about 90° .

5. The source according to claim 1 wherein the pre-pulse beam arrives at the target area in the range of 20-200 ns before the main pulse beam.

6. The source according to claim 1 further comprising a controller, said controller controlling the timing between the pre-pulse beam and the main pulse beam so as to control the intensity of the EUV radiation generated by the source.

7. The source according to claim 6 wherein the controller sets the timing between the pre-pulse beam and the main pulse beam to be less than 160 ns to provide a predetermined percentage of the maximum intensity of the EUV radiation.

8. The source according to claim 1 wherein the pre-pulse beam has an energy of about 10-40 mJ and the main pulse beam has an energy of about 0.1 to 1 J.

9. The source according to claim 1 wherein the at least one stream of the target material is selected from the group consisting of a frozen stream, a liquid stream, multiple streams and target droplets.

10. The source according to claim 1 wherein the target material is xenon.

11. An extreme (EUV) radiation source for generating EUV radiation, said source comprising:

a device for generating at least one stream of a target material, said target material being directed towards a target area;

a laser source generating a laser beam;

a beam splitter responsive to the laser beam and splitting the laser beam into a pre-pulse beam and a main pulse beam, said pre-pulse beam and said main pulse beam being directed towards the target area; and

a delay device for delaying the main pulse beam relative to the pre-pulse beam so that the pre-pulse beam arrives at the target area before the main pulse beam, and wherein the pre-pulse beam generates a weakly ionized plasma at the target area and the main pulse beam generates the EUV radiation.

12. The source according to claim 11 wherein the main pulse beam and the pre-pulse beam are separated by an angle in the range of 0° - 180° at the target area.

13. The source according to claim 12 wherein the angle is about 30° .

14. The source according to claim 12 wherein the angle is about 90° .

15. The source according to claim 11 wherein the pre-pulse beam arrives at a target area in the range of 20-200 ns before the main pulse beam.

16. The source according to claim 11 wherein the delay device controls the timing between the pre-pulse beam and the main pulse beam so as to control the intensity of the EUV radiation generated by the source.

17. The source according to claim 16 wherein the delay device sets the timing between the pre-pulse beam and the main pulse beam to be less than 160 ns to provide a predetermined percentage of the maximum intensity of the EUV radiation.

18. The source according to claim 11 wherein the pre-pulse beam has an energy of about 10-40 mJ and the main pulse beam has an energy of about 0.1 - 1J.

19. The source according to claim 18 wherein the at least one stream of the target material is selected from the group consisting of a frozen stream, a liquid stream, multiple streams and target droplets.

20. The source according to claim 11 wherein the target material is xenon.

21. An extreme (EUV) radiation source for generating EUV radiation, said source comprising:

a device for generating at least one stream of a target material, said target material being directed towards a target area; and

a system for generating a main pulse laser beam and a pre-pulse laser beam, wherein the main pulse beam and the pre-pulse beam are timed so that the pre-pulse beam arrives at the target area before the main pulse beam, and wherein the pre-pulse beam generates a weakly ionized plasma at the target area and the main pulse beam generates the EUV radiation.

22. The source according to claim 21 wherein the system includes a first laser source for generating the main pulse laser beam and a second laser source for generating the pre-pulse beam.

23. The source according to claim 21 wherein the system further includes a controller, said controller providing the timing between the main pulse beam and the pre-pulse beam.

24. The source according to claim 23 wherein the controller controls the timing between the pre-pulse beam and the main pulse beam to control the intensity of the EUV radiation generated by the source.

25. The source according to claim 24 wherein the controller sets the timing between the pre-pulse beam and the main pulse beam to be less than 160 ns to provide a predetermined percentage of the maximum intensity of the EUV radiation.

26. The source according to claim 21 wherein the system includes a single laser source for generating laser pulses and a beam splitter for splitting the laser pulses into the main pulse laser beam and the pre-pulse laser beam, said system further including a delay device for delaying the main pulse laser beam relative to the pre-pulse laser beam.

27. The source according to claim 21 wherein the main pulse beam and the pre-pulse beam are separated by an angle in the range of 0° - 180° at the target area.

28. The source according to claim 27 wherein the angle is about 30° .

29. The source according to claim 27 wherein the angle is about 90° .

30. The source according to claim 21 wherein the pre-pulse beam arrives at the target area in the range of 20-200 ns before the main pulse beam.

31. The source according to claim 21 wherein the pre-pulse beam has an energy of about 10 - 40 mJ and the main pulse beam has an energy of about 0.1 to 1 J.

32. The source according to claim 21 wherein the at least one stream of the target material is selected from the group consisting of a frozen stream, a liquid stream, multiple streams and target droplets.

33. A method for generating EUV radiation, comprising:
directing a stream or streams of a target material towards a target area;
directing a pre-pulse laser beam towards the target area; and
directing a main pulse beam towards the target area, wherein the pre-pulse beam arrives at the target area before the main pulse beam, and wherein the pre-

pulse beam generates a weak plasma at the target area and the main pulse beam interacts with the plasma to generate the EUV radiation.

34. The method according to claim 33 wherein the pre-pulse beam arrives at the target area in the range of 20-200 ns before the main pulse beam.

35. The method according to claim 33 further comprising setting the timing between the pre-pulse beam and the main pulse beam to control the intensity of the EUV radiation.

36. The method according to claim 35 wherein setting the timing includes reducing the time between the pre-pulse beam and the main pulse beam so that the intensity of the EUV radiation is a predetermined amount less than its maximum intensity.

37. The method according to claim 33 wherein the main pulse beam and the pre-pulse beam arrive at the target area separated by an angle in the range of 0° - 180° .

38. The method according to claim 33 wherein directing a stream of a target material includes directing a stream of a target material selected from the group consisting of a frozen stream, a liquid stream, multiple streams and target droplets.